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Interaction of Slow, Highly Charged Ions with Fullerenes

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The fragmentation of fullerenes following slow, highly charged ion (Xe^{44+}, Au^{69-}) impact has been studied by means of TOF spectroscopy. Highly charged ions (Au^{69+}, ~2keV/amu) produced by the LLNL electron beam ion trap (EBIT) impinged on a C_{60} thin film vacuum deposited on a Si(100) wafer. These highly charged ions carry a great deal of potential energy, e. g. 160 keV for Au^{69+}, to the thin film. The stability of the molecular, C_{60} cluster upon high electronic excitation is investigated; as is the mechanism of energy dissipation for molecular and cluster targets, which will illuminate the highly charged ion-surface interaction.

Large cluster fragments have been observed and the production mechanism is discussed on the basis of the "Coulomb explosion" model. The interaction of $Ar^{(17,18)+}$ ions with C_{60} has also been studied by observing coincidences between Ar K x-rays and the fullerene ions and fragments. At large distances the capture of electrons from C_{60} into excited states of the ion has been observed and compared to the interaction of the same ions with surfaces. Most of the observed events correspond to the capture of many electrons by the ion and subsequent Auger de-excitation. These results show clearly the characteristic behavior of ions flying over a surface without contact.

The highly charged ion impact induced the desorption and fragmentation of C_{60}. C_{60}^+ is the dominant peak in the positive ion time-of-flight spectrum for C_n, n>30. C_{58}^+, C_{56}^+, and C_{54}^+ were also observed with decreasing intensity. Interestingly, no add-on species (i. e. C_{62}+) could be observed. C_n^+ cluster intensities, for n<30, were observed to decay exponentially with cluster size. In addition C_n^+ clusters with n odd had a higher intensity than C_n^+ clusters with n even, i.e. odd-even oscillations were observed.

Surprisingly, negative ion clusters induced by highly charged ion impact were observed in the negative time-of-flight spectrum. No C_{60}^- was observed, suggesting that electron capture during desorption is not an efficient mechanism for highly charged ion-induced desorption. C_n^- cluster intensities, for n<30, were observed to decay exponentially with cluster size with the same factor as the positive ions. C_n^- clusters with n even had a higher intensity than C_n^- clusters with n odd, in contrast to the positive clusters.

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